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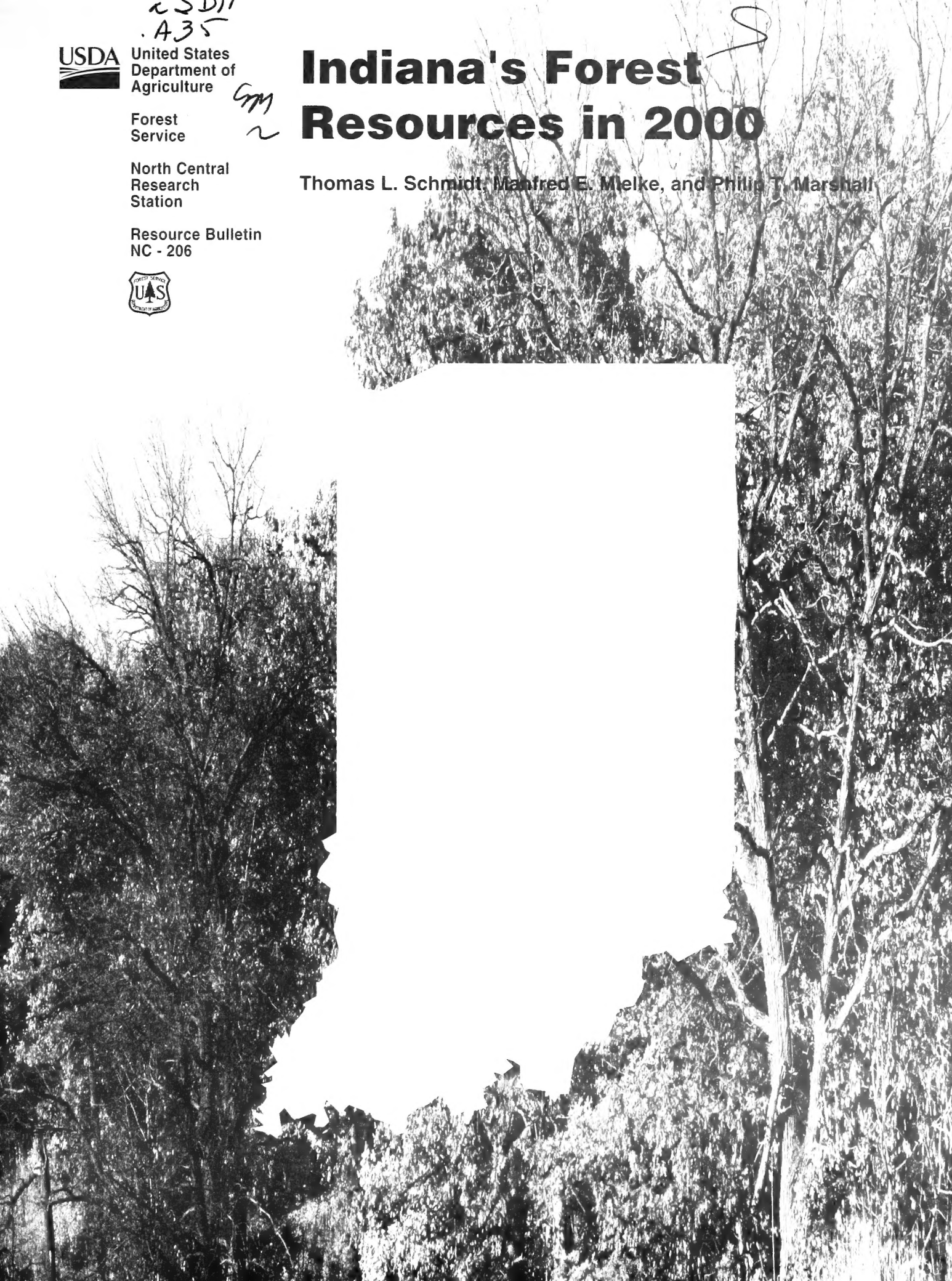
# Indiana's Forest Resources in 2000

Thomas L. Schmidt, Manfred E. Mielke, and Philip T. Marshall



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# CONTENTS

**Results** . . . . . **2**

Area . . . . . 2

Volume . . . . . 5

Biomass . . . . . 6

Forest Health . . . . . 6

Summary . . . . . 8

**Appendix** . . . . . **10**

Inventory Methods . . . . . 10

Sampling Phases . . . . . 11

Phase 1 . . . . . 11

Phase 2 . . . . . 11

**Literature Cited** . . . . . **14**

**Table Titles** . . . . . **15**

**Tables** . . . . . **16**

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# Indiana's Forest Resources in 2000

The North Central Research Station's Forest Inventory and Analysis Program (NCFIA) began fieldwork for the fifth forest inventory of Indiana's forest resources in 1999. This inventory initiated the new annual inventory system in which one-fifth of the field plots (considered one panel) in the State are measured each year. A complete inventory consists of measuring and compiling the data for all plots (or five panels). Once all panels have been measured, each panel will be remeasured approximately every 5 years. For example, in Indiana, the plots in the 1999 panel will be remeasured in 2004.

In 2000, NCFIA continued the annual inventory effort with the second panel of the fifth forest inventory. This fifth inventory of Indiana's forest resources will be completed in 2004. However, because each year's sample is a systematic sample of the State's forest and because timely information is needed about Indiana's forest resources, estimates have been prepared from data gathered during the first 2 years of the inventory. Data presented in this report represent 40 percent of the field plots (or two panels) for a complete inventory and are a combination of the first year's panel from 1999 and the second year's panel from 2000. **Because of the limited number of field plots measured, sampling errors are large and data in this report should be used with caution. Future estimates that incorporate data in this report are subject to change when ensuing annual inventories are completed and data compiled.** Results presented are estimates based on sampling techniques. As additional annual inventories are completed, the precision of the estimates will increase and additional data will be released.

Reports of previous inventories of Indiana are dated 1950, 1967, 1986, and 1998. Data from new inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have occurred since the last Indiana inventory in 1998 (Schmidt *et al.* 2000). (See appendix). Some of these changes make it inappropriate to directly compare portions of the 2000 data with those published for 1998.

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## RESULTS

### Area

It has been estimated that in the period between European settlement and the 1950s, Indiana's area of forest land dramatically decreased, especially in the southern areas of the State. To access recent trends in forest land area, timberland[1] area statistics from NCFIA inventories are compared. Timberland area statistics are used as a surrogate for forest land because sampling errors were derived for each inventory estimate of timberland but not for forest land area. Tracking timberland is particularly useful for accessing trends in forest land in Indiana because timberland area accounts for approximately 97 percent of all forest land in the State. In 1950, timberland area in Indiana was estimated to be 4.10 million acres. Between 1950 and 1967, the area of timberland continued to decline until by 1967 only an estimated 3.90 million acres remained (Spencer 1969) (fig. 1). However, by 1986, the estimated total area of timberland in Indiana had increased to 4.30 million acres (Smith and Golitz 1988). The trend of increasing area of timberland in Indiana continued on, evidenced by the 1998 inventory estimate of 4.34 million acres of timberland (Schmidt *et al.* 2000). However, initial results from the most recent annual inventory show that the trend of increasing area of timberland may have stalled in 2000. Indiana had an estimated 4.29 million acres of timberland. Analysis of the 1998 and 2000 inventories indicate that the current estimated total area of timberland may be a result of high sampling errors associated with a partial inventory rather than an actual loss of timberland between 1998 and 2000 (Hansen *et al.* 2001). As succeeding annual inventories are completed, sampling errors will decrease, resulting in increased precision of the estimates and a more reliable picture of reality.

The increase in total area of forest land since the 1960s and 1970s was partially due to changes in agricultural practices and policies. New forest lands came from the conversion of pasture and croplands through both natural processes and human intervention (tree planting and wildfire control). In many cases, these new forest lands had been partially covered with trees but initially did not have sufficient tree cover to qualify as forest land.

1 *Timberland, a subset of forest land, is capable of growing trees at a minimum level of 20 cubic feet per acre per year and is not restricted from harvest.*

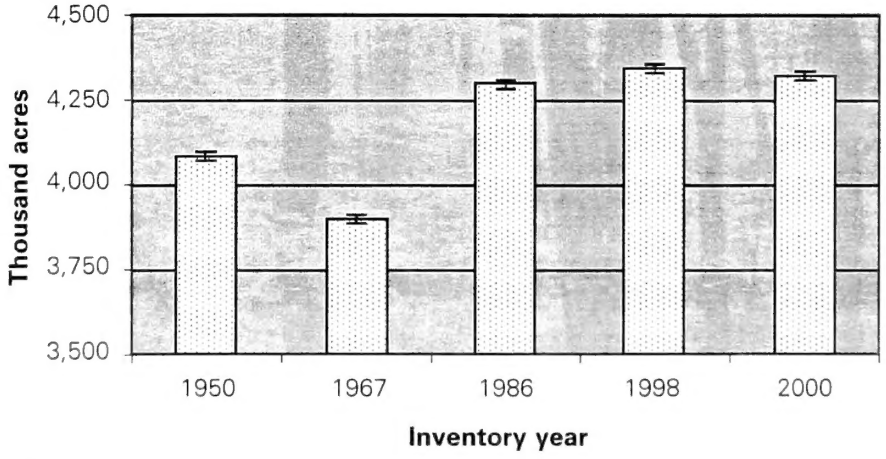


*Figure 1. — Area of timberland in Indiana by inventory year.*

However, as these lands gradually added more trees and existing trees continued to grow, they attained a level of stocking sufficient to qualify as forest land. An example of this process is the narrow wooded strips along Indiana's rivers and streams. In the 1950s, 1960s, and 1970s, these strips contained either scattered trees or were less than 120 feet in width from bole to bole, but by the 1980s and 1990s, they had widened to the point where they qualified as forest land. It is expected that in Indiana this process will continue to add forest lands, but those expected additions might be counterbalanced by losses at other sites due to development and other land uses (Schmidt *et al.* 2000). Sites where new forests are being established may differ from sites where forest land is lost to other land uses. The different sites may have different levels of productivity, different potential species compositions, and different owners.

In 2000, 16 percent of Indiana's 4.42 million acres of forest land were publicly owned (table 1). The shortleaf pine and oak-hickory forest types had above average rates of public ownership, 71 percent and 25 percent, respectively, while the maple-beech forest type had a below average rate of public ownership (less than 10 percent). The above average rate of public ownership of oak-hickory is partially due to the management objectives of maintaining oak on public forest lands.

The remaining portions of this analysis focus on timberlands. The 126.2 thousand acres of forest lands not included in the timberland classification are reserved forest lands, where harvesting is restricted, and other forest lands that do not meet the minimum growth levels. Of the 4.29 million acres of timberland, about 96 percent is naturally occurring and 4 percent has been artificially established (planted) (table 2).

Conifers play only a minor role in Indiana; only 2 percent of the total timberland area had conifers as the dominant species. Of the conifer dominated timberland area, 3 out of every 4 acres were artificially established through tree planting (table 2). All of the publicly owned conifer timberlands that were sampled in the 1999 and 2000 annual inventories were established by tree planting. In general, these public lands were privately owned marginal farmland that was abandoned, reverted to public ownership, and planted to conifers to prevent soil erosion. As a comparison, only 3 out of every 100 acres of deciduous dominated timberlands were artificially established. The low level of deciduous artificial regeneration is primarily due to the natural regeneration abilities of deciduous species in Indiana, which limits the need for this type of management.

Indiana has long been recognized as having some of the finest stands of deciduous forests in the Nation (Brundage 1955). Deciduous trees dominated timberlands in Indiana in 2000 with oak-hickory and maple-beech each accounting for about 40 percent of the total area (fig. 2). Bottomland hardwoods such as the elm-ash-cottonwood and oak-gum-cypress forest types represented 14 percent of all timberlands, and oak-pine, aspen-birch, or nonstocked made up the remaining 6 percent (table 3).

The average stand age, and resulting stand-size class, of Indiana's timberlands is increasing due to a lack of disturbance sufficient enough to decrease the average stand-size class. Disturbances can be either natural (wildfires,

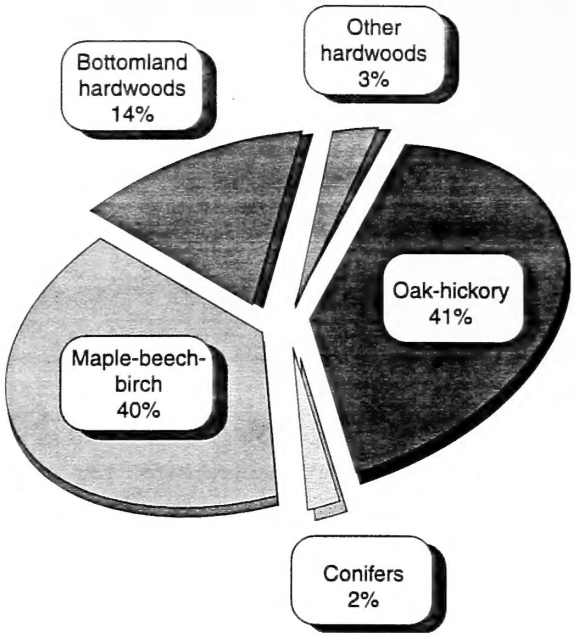


*Figure 2. — Area of timberland in Indiana in 2000 by forest type.*

flooding, insect epidemics, winds) or human-induced (harvesting, timber stand improvement, prescribed fire). This aging/maturing from a lack of disturbance is exhibited by the increase in the area classified as being in large diameter stands (historically referred to as sawtimber—stands with a plurality of stocking in trees more than 11.0 inches in diameter at breast height (d.b.h.), d.b.h. for deciduous species and 9.0 inches d.b.h. for conifers) (fig. 3). The amount of timberland in the large diameter stand-size class rose from 51 percent in 1950 to 70 percent in both 1998 and 2000. This increase came primarily at the expense of the small diameter stand-size class (stands with a plurality of stocking in trees with diameters of less than 5.0 inches d.b.h.). While most timberlands experienced some disturbance on a regular basis (even one tree dying can be viewed as a disturbance), it was generally not to the degree necessary to alter the stand-size class. But the increase in stand-size class might be leveling off; significant additional increases in area of timberland in

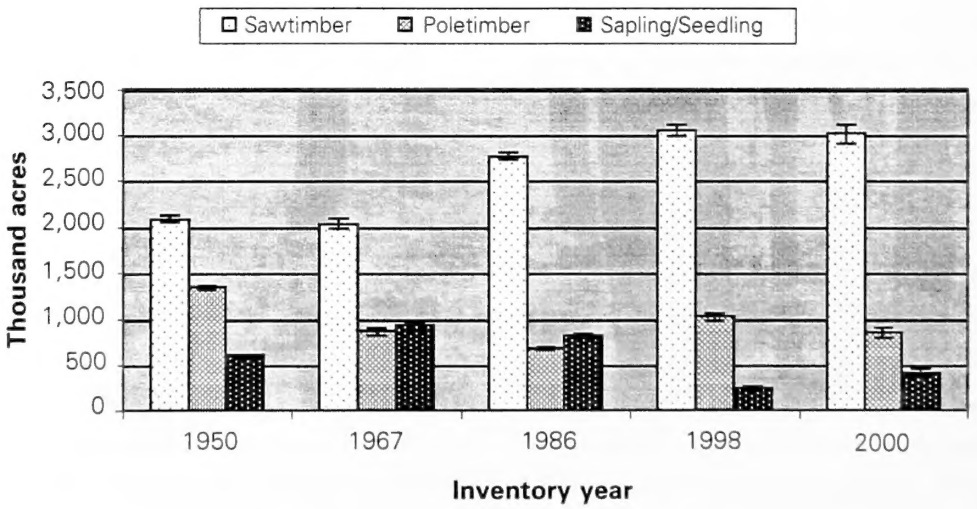


*Figure 3. — Area of timberland in Indiana by stand-size class by inventory year.*

large diameter classes are not expected for the future. However, the species composition of these stands might change as more shade-tolerant species replace those species that regenerate after disturbance or with full sunlight on the forest floor. Also, the increased amount of large diameter class and older timberlands is creating a mono-culture of old/mature stands that are at greater risk of large-scale mortality from natural events, such as drought or insect epidemics. At a time when a new insect threat, gypsy moth, is at the "edge of Indiana's timberland," having a monoculture of old/mature timberland largely dominated by oak, the preferred host of gypsy moth, presents a risk to Indiana's timberland.

In 2000, the oak-hickory forest type in Indiana had an above average amount of timberland in the large diameter stand-size class; 82 percent of all oak-hickory dominated stands were considered large diameter. This raises concerns because oak-hickory without disturbance can convert to other forest types such as maple-beech. Oak-hickory stands are of vital importance for Indiana due to their ecological and economical contributions.

## Volume

Historically, volume has been reported as either growing stock or sawtimber. However, there are volumes in noncommercial trees, rotten trees, and rough trees that do not qualify as growing stock but that are utilized for wood fiber and fuelwood and that make important ecological contributions (such as wildlife habitat, and soil and water protection). With the annualized inventory system and increased interest in FIA data from an ecological perspective, a greater focus has been placed on all live volume. As a result, tables 4 and 5 of this report focus on all live volume. In 2000, Indiana had almost 7.8 billion cubic feet of all live volume on its 4.42 million acres of forest land. This equates to an average of more than 1,750 cubic feet of all live volume for each forest land acre in Indiana. Unfortunately, data for all live volume are not readily available from the historic inventories and thus comparisons consider only growing-stock volume.

In addition to the all live volume, Indiana had more than 106 million cubic feet in salvable dead trees. Salvable dead trees are standing trees with less than half of their volume rotten. These trees make important contributions to wildlife habitat, provide diversity within the forested landscape, and can be utilized for fuelwood and wood products.

Indiana's growing-stock volume, at 6.71 billion cubic feet, represents 87 percent of the total all live volume (table 5). Growing-stock volume is the amount of solid wood on timberland in commercial trees 5.0 inches d.b.h. and over, from 1 foot above ground (stump) to a minimum 4.0-inch top diameter with deductions made for poor form or defect. As trees increase in diameter and as timberlands increase their stocking, growing-stock volume typically also increases. Of the total growing-stock volume, 80 percent is in large diameter stands and 20 percent is in medium stands (historically classified as poletimber—trees with d.b.h. between 5.0 inches and either 9.0 inches for conifers or 11.0 inches for deciduous species). In addition, 23 percent of all growing-stock volume in Indiana in 2000 was in trees with diameters greater than 21.0 inches d.b.h. (table 7).

Indiana had 3.65 billion cubic feet of growing-stock volume in 1967, 5.18 billion cubic feet in 1986, 6.90 in 1998, and 6.71 in 2000 (fig. 4). Total growing-stock volume on timberland in Indiana increased by 84 percent between 1967 and 2000, as a result of the care, interest, and management shown by Hoosiers for their forests.

Indiana averaged 1,560 cubic feet per acre of growing-stock volume on timberland in 2000 compared to 680 in 1950. The 2000 average is similar to that of 1998 when Indiana averaged 1,589 cubic feet per acre of growing stock on timberland. Both the 1998 and 2000 growing-stock volume estimates fall within the same sampling error range, implying no statistical difference between the two estimates. In comparison, Michigan averaged 1,431 cubic feet per acre in 1993 (Schmidt *et al.* 1997).

Of the total growing-stock volume in Indiana in 2000, 28 percent was oak, 12 percent hickory, 12 percent yellow-poplar, 12 percent maple, 7 percent ash, and 4 percent conifers. No other species group represented more than 3.5 percent.

## Biomass

Biomass, measured as all live aboveground tree biomass on timberlands in Indiana, was estimated at more than 211 million dry tons in 2000 (an average of more than 28 dry tons per acre). Biomass is an important measure because it provides information that can be used for analyses related to carbon sequestration, wood fiber availability for fuel, and other issues. More than 80 percent of the total biomass was in growing-stock trees, 13 percent was in non-growing-stock trees, and the remaining 7 percent was in trees less than 5.0 inches d.b.h. As expected, deciduous species dominated in Indiana in 2000, accounting for about 98 percent of all biomass.

## Forest Health

Indiana forests have sustained damage from a variety of agents over the years. Many of these agents have the potential to cause significant impact to the resource, but most of the long-term impact is more subtle, causing growth loss, defect, and under high stress conditions, mortality. An in-depth analysis of the status of Indiana's forests from a health and sustainability perspective is available at: http://www.na.fs.fed.us/spfo/fhm/fhh/fhh-01/in/in_01.htm.

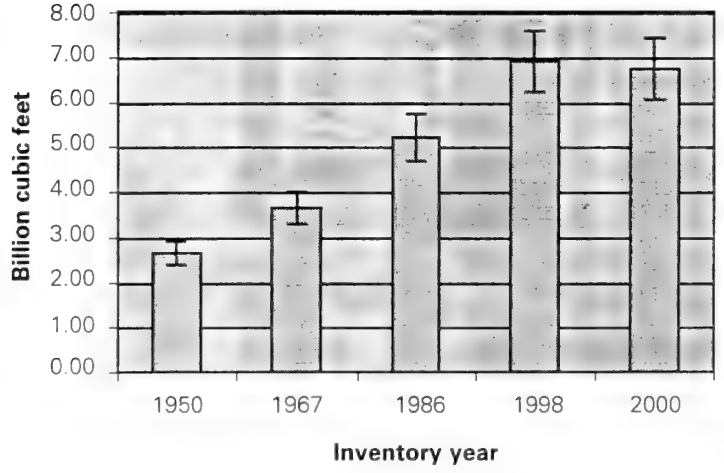


*Figure 4. — Growing-stock volume in Indiana by inventory year.*

The Indiana Department of Natural Resources Division of Forestry and the USDA Forest Service's State and Private Forestry Forest Health Protection Program work in concert to annually evaluate the health and condition of Indiana's forests. Current known pests identified through this cooperative effort include the gypsy moth, eastern tent caterpillar, oak wilt, jumping oak gall, locust leaf miner, white pine weevil, oak tatters, white pine root decline, butternut canker, ash decline, and pine shoot beetle.

Indiana's gypsy moth management program is holding gypsy moth in place in the extreme northern portion of Indiana judging from the number of male moths detected and the location of positive traps in 2001 (see tabulation below).

An epidemic of the jumping oak gall discolored the white oak in the forests of south central Indiana in May and June of 1999—the first occurrence of this gall in Indiana's forests. Jumping oak gall forms in late May and early June on the underside of the foliage. One or more species of a Cynipid wasp (Neuroterus spp.) form the gall that causes the leaves to yellow and turn brown. The damage in 1999 started along the Ohio River and went north through Perry County extending to Martin and Lawrence Counties and east to Washington County. The gall was also reported in the middle of the State—Johnson, Hendricks, and Wayne Counties. An aerial survey estimated that white oak was discolored on one million acres of forest land. The gall was still present in 2000 and 2001 but did not discolor the white oak.

In 2000 and 2001, the eastern tent caterpillar was at epidemic levels in Indiana, causing moderate to complete defoliation of black cherry in the southern and south central parts of the State. Trees were defoliated in every location from fence row to forest. Most forest land in south central Indiana experienced some level of eastern tent caterpillar defoliation if black cherry was present.

Butternut canker affects butternut trees throughout the State. Since 1995, landowners have reported nine butternut trees that may be tolerant or resistant to the disease. Although work limitations have slowed the screening of reported trees, landowners are still encouraged to locate and report healthy butternut trees to their district forester, forest health specialist, or the Indiana Division of Forestry.

Procera root rot (white pine root decline) has been killing white pine across the State for the past 10 years. It continues to kill windbreak, yard, and plantation trees. This disease is the

*Number of gypsy moths trapped in Indiana each year by the Indiana Department of Natural Resources Forestry Division and the Forest Service's Northeastern Area State and Private Forestry*

| **Year** | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|
| **Number of moths** | 5,798 | 61,994 | 81,995 | 13,498 | 5,881 | 14,031 |

most common forest pest for which landowners request assistance. Trees from 4 to 30 feet tall and 3 to 6 inches in diameter are commonly killed. Trees can turn brown at any time of the year, but do so more commonly in the spring and fall. Infected trees appear light green and sparse or thin at first, and soon turn brown. Most landowners do not recognize the early symptoms of the disease. They usually see the dead brown tree and sawdust from woodborers that attack the dead tree. The disease can be managed through sanitation measures, but there is no cure or preventative treatment.

The drought of 1999 and localized droughts of previous years continue to have an effect on the forests of Indiana. Since 1999, and continuing through 2001, reports of dying oaks, ash, and yellow-poplar have been received, mainly from southern Indiana. The decline and mortality may be greater for yellow-poplar than for the oaks or other species. Yellow-poplar develops cankers on the main branches of the tree crown. Gradually the top dies back and the tree eventually dies. Following death, the bark quickly falls off, the top decays, and the heartwood may develop a dark stain. There is no information from prior droughts to help guide management for yellow-poplar. Experience from the 1987/1988 drought and the forest tent caterpillar and looper epidemics of the late 1970s and early 1980s found that black oak died first followed by scarlet, red, and then other oak species. The disease "ash yellows," a disease more commonly found in the Northern and Lower Wabash FIA Inventory Units, also influences the ash mortality associated with drought.

Although oak wilt occurs across the State, it is most common and the most evident killer of red oak trees in the western half of the Northern Unit. Oak wilt was confirmed from black and red oak in one location in Grant County in 2001, which was the first confirmed identification of the fungus in this County. Oak wilt has been detected in 62 counties since the disease was first reported over 50 years ago (fig. 5). Oak wilt occurred in spots in one forest; it apparently had been there for 2 years before it was discovered because it had already killed some oaks. The location had both means of oak wilt spread: root graft transmission between oaks and insect spread to an isolated red oak.

## Summary

Indiana's forest resources appear to be reasonably healthy, but there are concerns as the resource continues to age and grow more susceptible to invasive insect species. As additional data become available from ensuing annual inventories, a clearer picture of the trends in Indiana's forests will emerge. Additional data related to the most recent three inventories of Indiana (1986, 1998, 2000) are available at: www.ncrs.fs.fed.us/4801/fiadb/index.htm.


*Figure 5. — Counties in Indiana with oak wilt present in 2001 (Source: USDA Forest Service, State and Private Forestry Forest Health Protection Program).*

# APPENDIX

## Inventory Methods

Miles (2001) provides a full description of the NCFIA annualized inventory methods for Indiana. Since the 1998 inventory of Indiana, several changes have been made in NCFIA inventory methods to improve the quality of the inventory as well as meet increasing demands for timely forest resource information. The most significant difference between inventories was the change from periodic inventories to annual inventories. Historically, NCFIA periodically inventoried each State on a cycle that averaged about 12 years. However, the need for timely and consistent data across large geographical regions, combined with national legislative mandates, resulted in NCFIA's implementation of an annual inventory system. Indiana was one of the first States in the North Central region, and one of the first States in the Nation, to be inventoried with this new system, beginning with the 1999 inventory.

With an annual inventory system, about one-fifth of all field plots are measured in any one year. After 5 years, an entire inventory cycle will be completed. After the first 5 years, NCFIA will report and analyze results as a moving 5-year average. For example, NCFIA will be able to generate a report based on inventory results for 1999 through 2004 or for 2001 through 2006. While there are great advantages for an annual inventory, one difficulty is reporting on results in the first 4 years. With the 2000 inventory, only 40 percent of all field plots have been measured. Sampling error estimates for the 2000 inventory results are area of forest land 2.90 percent, area of timberland 2.99 percent, number of growing-stock trees on timberland 5.53 percent, volume of growing stock on timberland 4.53 percent, and volume of sawtimber on timberland 5.28 percent. These sampling error estimates are considerably higher than those for the last periodic inventory completed in 1998 (i.e., 1.59 percent for timberland area and 2.18 percent for growing-stock volume) because of the smaller sample sizes. Thus, caution should be used when drawing conclusions based on this limited data set. As we complete ensuing measurements, we will have additional confidence in our results due to the increased number of field plots measured. As each measurement year is completed, the precision of estimates will improve.

Other significant changes between inventories include the implementation of new remote sensing technology, the implementation of a new field plot design, and the gathering of additional remotely sensed and field data. The advent of remote sensing technology since the previous inventory in 1998 has allowed NCFIA to use computer-assisted classifications of Multi-Resolution Land Characterization (MRLC) data and other available remote sensing products to stratify the total area of the State and to improve estimates. Inventories in Indiana before 1998 used manual interpretation of aerial photos to stratify the sample in 1950, 1967, and 1986. The 1998 stratification was based on the Gap Analysis Program (GAP) classification of satellite imagery.

New algorithms were used in 2000 to assign forest type and stand-size class to each condition observed on a plot. These algorithms are being used nationwide by FIA

to provide consistency among States and will be used to reassign the forest type and stand-size class of every plot measured in the 1998 inventory when it is updated. This will be done so that changes in forest type and stand-size class will more accurately reflect actual changes in the forest and not changes in how values are computed. The list of recognized forest types, grouping of these forest types for reporting purposes, equations used to assign stocking values to individual trees, definition of nonstocked (stands with a stocking value of less than 10 percent for all live trees), and names given to the forest types changed with the new algorithms. As a result, comparisons between the published 1998 inventory results and those published for the 2000 inventory may not be valid. For additional details about algorithms used in both inventories, please contact NCFIA.

## Sampling Phases

The 2000 Indiana survey used a two-phase sample for stratification that included remeasuring inventory plots from the 1998 inventory and measuring new field plots. Two-phase sampling, also called double sampling, consists of a phase 1 sample to estimate area by strata and a phase 2 sample to estimate the average value of parameters of interest within these strata. The estimated population total for a parameter is the sum across all strata of the product of each stratum's estimated area and the parameter's estimated mean per unit area.

The only land that could not be sampled was private land where field personnel could not obtain permission from the owner to measure the field plot. The methods used in the preparation of this report make the necessary adjustments to account for sites where access was denied or hazardous. Fortunately, there were no denied access plots in 1999 and only 2 denied access plots in 2000.

### Phase 1

The 2000 inventory used a computer-assisted classification of satellite imagery. FIA used the imagery to form two initial strata—forest and nonforest. Pixels within 60 m (2 pixel widths) of a forest/nonforest edge formed two additional strata—forest/nonforest and nonforest/forest. Forest pixels within 60 m on the forest side of a forest-nonforest boundary were classified into forest/nonforest strata. Pixels within 60 m of the boundary on the nonforest side were classified into nonforest/forest strata. An overlay of all national forest land was used to identify all lands owned by the Hoosier National Forest. These national forest lands were treated separately but were also stratified into one of the above four strata. Stratification and estimation were conducted at the State level for national forest lands and at the FIA Inventory Unit level for other lands. In the national forest stratum, forest and forest/nonforest strata were combined.

### Phase 2

Phase 2 of the inventory consisted of the measurement of the annual sample of field plots in Indiana. Current FIA precision standards for annual inventories require a sampling intensity of one plot for approximately every 6,000 acres. FIA has established a grid that divides the entire area of the United States into non-overlapping hexagons, each of which contains approximately 5,937 acres (McRoberts 1999). A grid of field plots was established by

selecting one plot from each hexagon based on the following rules: (1) if a Forest Health Monitoring (FHM) plot (Mangold 1998) fell within a hexagon, it was selected as the grid plot; (2) if no FHM plot fell within a hexagon, the existing NCFIA plot from the 1998 inventory nearest the hexagon center was selected as the grid plot; and (3) if neither FHM nor existing NCFIA plots fell within the hexagon, a new NCFIA plot established at the hexagon center was selected as the grid plot (McRoberts 1999). This grid of plots is designated the Federal base sample and is considered an equal probability sample; its measurement in Indiana is funded by the Federal government.

The total Federal base sample of hexagonal grid plots was systematically divided into five interpenetrating, non-overlapping subsamples or panels. Each year the plots in a single panel are measured, and panels are selected on a 5-year, rotating basis (McRoberts 1999). For estimation purposes, the measurement of each panel of plots may be considered an independent random sample of all land in a State. Field crews measure vegetation on plots forested at the time of the last inventory and on plots currently classified as forest by trained photointerpreters using aerial photos or digital ortho-quads.

NCFIA has two categories of field plot measurements—phase 3 plots (FHM plots) and phase 2 field plots—to optimize our ability to collect data when available for measurement. Both types of plots are uniformly distributed both geographically and temporally. Phase 3 plots are measured with the full suite of FHM vegetative and health variables (Mangold 1998) collected as well as the full suite of measures associated with phase 2 plots. Phase 3 plots must be measured between June 1 and August 30 to accommodate the additional measurement of non-woody understory vegetation, ground cover, soils, and other variables. We anticipate that in Indiana the complete 5-year annual inventory will involve about 60 phase 3 plots. On the remaining plots, referred to as phase 2 plots, only variables that can be measured throughout the entire year are collected. In Indiana, the complete 5-year annual inventory is expected to involve about 860 phase 2 forested plots. The 1999/2000 annual inventory results represent field measures on 290 timberland, 6 other forest land, and 143 non-forest land plots.

The new national FIA 4-point cluster plot design (fig. 6) was first used for data collection during the 1998 inventory of Indiana. This design was also used in the 1999 and 2000 inventories and will be used in subsequent years. The national plot design requires mapping forest conditions on each plot. Due to the small sample size (20 percent) each year, precision associated with change factors such as mortality will be relatively low. Consequently, we will not report change estimates until at least three annual panels have been measured, and even then we anticipate that estimates of change will be limited in detail. When the complete annual inventory has been implemented in 2004, the full range of change variables will be available.

The overall plot layout for the new design consists of four subplots. The centers of subplots 2, 3, and 4 are located 120 feet from the center of subplot 1. The azimuths to

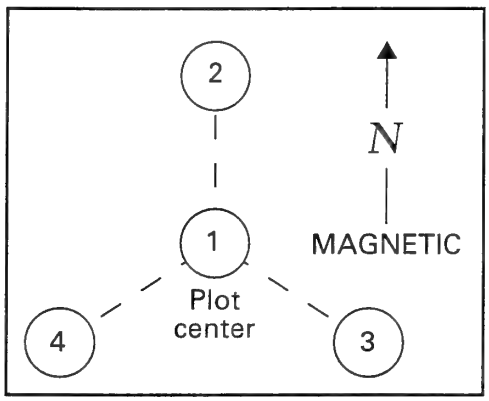


*Figure 6. —Current NCFIA field plot design.*

subplots 2, 3, and 4 are 0, 120, and 240 degrees, respectively. The center of the new plot is located at the same point as the center of the previous plot if a previous plot existed within the sample unit. Trees with diameter at breast height (d.b.h., or 4.5 feet above ground level) 5 inches and larger are measured on a 24-foot-radius (1/24 acre) circular subplot. All trees less than 5 inches d.b.h. are measured on a 6.8-foot-radius (1/300 acre) circular microplot located at the center of each of the four subplots. Forest conditions that occur on any of the four subplots are recorded. Factors that differentiate forest conditions are changes in forest type, stand-size class, land use, ownership, and density. Each condition that occurs anywhere on any of the subplots is identified, described, and mapped if the area of the condition meets or exceeds 1 acre in size.

Field plot measurements are combined with phase-1 estimates in the compilation process and table production. The number of tables generated from a single year's data is limited. However, as additional annual inventories are completed, the number of tables will increase until year 5, when all statewide inventory summary tables will be available in both printed and electronic formats. For additional information, contact:

Program Manager
Forest Inventory and Analysis
North Central Research Station
1992 Folwell Ave.
St. Paul, MN 55108

Or

State Forester
Indiana Department of Natural Resources
Division of Forestry
402 W. Washington St., Room W296
Indianapolis, IN 46204

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## TABLE TITLES


Table 1.—*Area of forest land by forest type group and owner category, Indiana, 1999-2000*

Table 2.—*Area of timberland by major forest type group, stand origin, and owner category, Indiana, 1999-2000*

Table 3.—*Area of timberland by forest type group and stand-size class, Indiana, 1999-2000*

Table 4.—*Net volume of all live trees on forest land by species group and owner category, Indiana, 1999-2000*

Table 5.—*Net volume of all live trees and salvable dead trees on timberland by class of timber and softwood/hardwood categories, Indiana, 1999-2000*

Table 6.—*Net volume of growing stock on timberland by forest group and softwood/hardwood species categories, Indiana, 1999-2000*

Table 7.—*Net volume of growing stock on timberland by species group and diameter class, Indiana, 1999-2000*

Table 8.—*Net volume of sawtimber on timberland by species group and diameter class, Indiana, 1999-2000*

Table 9.—*All live abovegroud tree biomass on timberland by owner category, softwood/hardwood category, and tree biomass component, Indiana, 1999-2000*

# TABLES

Table 1. -- Area of forest land by forest type group and owner category, Indiana, 1999 - 2000

(In thousand acres)

| Forest type group | Owner category | | | |
|---|---|---|---|---|
| | All owners | Public | Private | Unidentified owner |
| **Softwood type groups** | | | | |
| Unavailable | 31.7 | -- | -- | 31.7 |
| White / red / jack pine group | 29.5 | -- | 29.5 | -- |
| Loblolly / shortleaf pine group | 35.7 | 25.2 | 10.5 | -- |
| Pinyon / juniper group | 23.8 | -- | 23.8 | -- |
| All softwood types | 120.7 | 25.2 | 63.8 | 31.7 |
| **Hardwood type groups** | | | | |
| Oak / pine group | 108.7 | 13.3 | 95.5 | -- |
| Oak / hickory group | 1,814.8 | 442.8 | 1,372.0 | -- |
| Oak / gum / cypress group | 75.6 | 16.2 | 59.4 | -- |
| Elm / ash / cottonwood group | 535.4 | 61.5 | 473.9 | -- |
| Maple / beech / birch group | 1,728.4 | 150.1 | 1,578.3 | -- |
| Aspen / birch group | 9.3 | 4.0 | 5.2 | -- |
| All hardwood types | 4,272.2 | 687.9 | 3,584.3 | -- |
| Nonstocked | 22.5 | -- | 22.5 | -- |
| **All forest types** | 4,415.4 | 713.2 | 3,670.6 | 31.7 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their total due to rounding.

Table 2. -- Area of timberland by major forest type group, stand origin, and owner category, Indiana, 1999 - 2000

(In thousand acres)

| Major forest type group and stand origin | Owner category | | | |
|---|---|---|---|---|
| | All owners | Public | Private | Unidentified owner |
| **Softwood type groups** | | | | |
| Natural | 23.8 | -- | 23.8 | -- |
| Planted | 65.2 | 25.2 | 40.0 | -- |
| All softwood types | 89.0 | 25.2 | 63.8 | -- |
| **Hardwood type groups** | | | | |
| Natural | 4,054.4 | 590.4 | 3,464.0 | -- |
| Planted | 123.3 | 30.2 | 93.0 | -- |
| All hardwood types | 4,177.7 | 620.7 | 3,557.0 | -- |
| Nonstocked | 22.5 | -- | 22.5 | -- |
| **All groups** | 4,289.2 | 645.9 | 3,643.3 | -- |

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table 3. -- Area of timberland by forest type group and stand-size class, Indiana, 1999 - 2000

(In thousand acres)

| Forest type group | All stands | Stand-size class | | | |
|---|---|---|---|---|---|
| | | Sawtimber | Poletimber | Sapling-seedling | Non-stocked |
| **Softwood type groups** | | | | | |
| White / red / jack pine group | 29.5 | 16.4 | 13.1 | -- | -- |
| Loblolly / shortleaf pine group | 35.7 | 32.2 | 3.5 | -- | -- |
| Pinyon / juniper group | 23.8 | 4.0 | 1.0 | 18.8 | -- |
| All softwood types | 89.0 | 52.5 | 17.6 | 18.8 | -- |
| **Hardwood type groups** | | | | | |
| Oak / pine group | 108.7 | 77.6 | 15.6 | 15.5 | -- |
| Oak / hickory group | 1,744.0 | 1,429.3 | 241.5 | 73.2 | -- |
| Oak / gum / cypress group | 75.6 | 63.0 | -- | 12.6 | -- |
| Elm / ash / cottonwood group | 535.4 | 342.5 | 133.2 | 59.7 | -- |
| Maple / beech / birch group | 1,704.7 | 1,043.0 | 436.4 | 225.3 | -- |
| Aspen / birch group | 9.3 | 9.3 | -- | -- | -- |
| All hardwood types | 4,177.7 | 2,964.6 | 826.7 | 386.4 | -- |
| Nonstocked | 22.5 | -- | -- | -- | 22.5 |
| **All forest types** | 4,289.2 | 3,017.2 | 844.3 | 405.2 | 22.5 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0.0 indicates the acres round to less than 0.1 thousand acres. Columns and rows may not add to their totals due to rounding.

Table 4. -- Net volume of all live trees on forest land by species group and owner category, Indiana, 1999 - 2000

(In thousand cubic feet)

| Species group | Owner category | | | |
|---|---|---|---|---|
| | All owners | Public | Private | Unidentified owner |
| **Softwoods** | | | | |
| Loblolly and shortleaf pines | 38,327 | 36,361 | 1,965 | -- |
| Other yellow pines | 57,971 | 30,477 | 27,495 | -- |
| Eastern white and red pines | 69,949 | 3,561 | 66,388 | -- |
| Jack pine | 3,894 | -- | 3,894 | -- |
| Cypress | -- | -- | -- | -- |
| Other eastern softwoods | 81,382 | 16,506 | 64,876 | -- |
| Total softwoods | 251,523 | 86,905 | 164,618 | -- |
| **Hardwoods** | | | | |
| Select white oaks | 867,290 | 245,266 | 622,024 | -- |
| Select red oaks | 272,714 | 111,288 | 161,426 | -- |
| Other white oaks | 120,793 | 34,078 | 86,716 | -- |
| Other red oaks | 800,675 | 176,787 | 623,888 | -- |
| Hickory | 888,403 | 136,278 | 752,125 | -- |
| Hard maple | 716,934 | 89,452 | 627,482 | -- |
| Soft maple | 240,573 | 26,426 | 214,147 | -- |
| Beech | 267,409 | 47,452 | 219,957 | -- |
| Sweetgum | 60,105 | 33,474 | 26,632 | -- |
| Tupelo and blackgum | 78,208 | 11,532 | 66,676 | -- |
| Ash | 587,617 | 30,587 | 557,030 | -- |
| Cottonwood and aspen | 247,963 | 30,509 | 217,455 | -- |
| Basswood | 82,127 | 1,261 | 80,866 | -- |
| Yellow-poplar | 830,234 | 140,387 | 689,847 | -- |
| Black walnut | 217,868 | 15,492 | 202,376 | -- |
| Other eastern soft hardwoods | 1,033,694 | 94,296 | 939,398 | -- |
| Other eastern hard hardwoods | 135,398 | 9,586 | 125,812 | -- |
| Eastern noncommercial hardwoods | 59,362 | 387 | 58,974 | -- |
| Total hardwoods | 7,507,366 | 1,234,536 | 6,272,830 | -- |
| **All species groups** | 7,758,889 | 1,321,441 | 6,437,448 | -- |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates that the volume rounds to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 5. -- Net volume of all live trees and salvable dead trees on timberland by class of timber and softwood/hardwood categories, Indiana, 1999 - 2000

(In thousand cubic feet)

| Class of timber | All species | Softwood species | Hardwood species |
|---|---|---|---|
| **Live trees** | | | |
| **Growing-stock trees** | | | |
| Sawtimber | | | |
| Saw log portion | 4,703,027 | 155,911 | 4,547,117 |
| Upper stem portion | 594,107 | 18,724 | 575,383 |
| Total | 5,297,134 | 174,635 | 5,122,499 |
| Poletimber | 1,410,470 | 60,010 | 1,350,460 |
| **All growing-stock trees** | 6,707,604 | 234,645 | 6,472,959 |
| **Cull trees** | | | |
| Rough trees [1] | | | |
| Sawtimber size | 538,467 | 4,526 | 533,941 |
| Poletimber size | 222,353 | 5,069 | 217,284 |
| Total | 760,820 | 9,595 | 751,225 |
| Rotten trees [1] | | | |
| Sawtimber size | 110,702 | -- | 110,702 |
| Poletimber size | 15,635 | 294 | 15,341 |
| Total | 126,336 | 294 | 126,042 |
| **All live cull trees** | 887,156 | 9,889 | 877,267 |
| **All live trees** | 7,594,760 | 244,534 | 7,350,226 |
| **Salvable dead trees** | | | |
| Sawtimber size | 56,371 | 8,764 | 47,607 |
| Poletimber size | 50,705 | 5,100 | 45,604 |
| **All salvable dead trees** | 107,076 | 13,864 | 93,212 |
| **All classes** | 7,701,836 | 258,398 | 7,443,438 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates that the volume rounds to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding

[1] Includes noncommercial species

Table 6. -- Net volume of growing stock on timberland by forest group and softwood/hardwood species categories, Indiana, 1999 - 2000

(In thousand cubic feet)

| Forest type group | All species | Softwood species | Hardwood species |
|---|---|---|---|
| **Softwood type groups** | | | |
| White / red / jack pine group | 59,011 | 53,597 | 5,414 |
| Loblolly / shortleaf pine group | 83,041 | 72,938 | 10,103 |
| Pinyon / juniper group | 11,071 | 7,904 | 3,167 |
| All softwood types | 153,123 | 134,438 | 18,685 |
| **Hardwood type groups** | | | |
| Oak / pine group | 163,534 | 56,666 | 106,868 |
| Oak / hickory group | 3,121,805 | 12,650 | 3,109,155 |
| Oak / gum / cypress group | 161,902 | -- | 161,902 |
| Elm / ash / cottonwood group | 701,853 | 12,344 | 689,508 |
| Maple / beech / birch group | 2,374,209 | 18,546 | 2,355,663 |
| Aspen / birch group | 30,957 | -- | 30,957 |
| All hardwood types | 6,554,260 | 100,207 | 6,454,053 |
| Nonstocked | 221 | -- | 221 |
| **All forest types** | 6,707,604 | 234,645 | 6,472,959 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates that the volume rounds to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 7. – Net volume of growing stock on timberland by species group and diameter class, Indiana, 1999 - 2000

(In thousand cubic feet)

| Species group | All classes | Diameter class (inches at breast height) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5.0-6.9 | 7.0-8.9 | 9.0-10.9 | 11.0-12.9 | 13.0-14.9 | 15.0-16.9 | 17.0-18.9 | 19.0-20.9 | 21.0-28.9 | 29.0+ |
| **Softwoods** | | | | | | | | | | | |
| Loblolly and shortleaf pines | 37,150 | 392 | 3,342 | 3,958 | 10,724 | 7,392 | 7,206 | 4,136 | -- | -- | -- |
| Other yellow pines | 55,550 | 3,954 | 6,390 | 13,780 | 13,198 | 4,566 | 9,783 | 3,879 | -- | -- | -- |
| Eastern white and red pines | 69,949 | 1,307 | 6,854 | 9,393 | 18,731 | 5,863 | 18,299 | 3,329 | 6,174 | -- | -- |
| Jack pine | 3,894 | 206 | 1,081 | 1,561 | 1,046 | -- | -- | -- | -- | -- | -- |
| Cypress | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Other eastern softwoods | 68,102 | 16,008 | 20,478 | 17,539 | 7,586 | 6,491 | -- | -- | -- | -- | -- |
| Total softwoods | 234,645 | 21,867 | 38,144 | 46,231 | 51,286 | 24,312 | 35,289 | 11,344 | 6,174 | -- | -- |
| **Hardwoods** | | | | | | | | | | | |
| Select white oaks | 770,118 | 15,020 | 30,431 | 41,439 | 43,318 | 80,736 | 110,290 | 79,396 | 87,256 | 201,502 | 80,729 |
| Select red oaks | 293,205 | 6,899 | 12,393 | 15,400 | 21,707 | 25,076 | 31,158 | 27,083 | 17,512 | 61,320 | 14,657 |
| Other white oaks | 111,624 | 1,779 | 3,620 | 9,725 | 12,314 | 19,541 | 27,019 | 11,640 | 19,356 | 6,631 | -- |
| Other red oaks | 726,028 | 9,431 | 25,284 | 40,593 | 52,433 | 85,055 | 94,880 | 80,070 | 81,636 | 209,974 | 46,672 |
| Hickory | 830,153 | 20,741 | 58,039 | 88,452 | 115,233 | 129,985 | 145,563 | 125,962 | 73,009 | 43,748 | 29,421 |
| Hard maple | 607,090 | 53,222 | 56,189 | 76,928 | 88,667 | 69,032 | 88,019 | 78,198 | 12,316 | 67,876 | 16,644 |
| Soft maple | 190,655 | 22,816 | 37,425 | 30,657 | 23,262 | 27,960 | 19,500 | 8,002 | 9,462 | 11,572 | -- |
| Beech | 196,490 | 3,171 | 8,150 | 6,838 | 13,852 | 8,754 | 8,227 | 36,196 | 5,366 | 93,266 | 12,669 |
| Sweetgum | 58,291 | 6,443 | 10,376 | 10,331 | 15,615 | 3,838 | 3,325 | 3,246 | 5,115 | -- | -- |
| Tupelo and blackgum | 66,732 | 6,307 | 6,261 | 5,772 | 5,963 | 5,446 | 8,887 | 8,030 | 3,995 | 16,070 | -- |
| Ash | 467,252 | 19,776 | 38,768 | 59,603 | 65,374 | 80,843 | 62,830 | 65,955 | 38,038 | 36,065 | -- |
| Cottonwood and aspen | 242,947 | 2,723 | 3,550 | 8,067 | 15,437 | 15,846 | 22,458 | 12,207 | 23,031 | 72,212 | 67,417 |
| Basswood | 62,938 | 3,396 | 7,039 | 12,208 | 7,029 | 6,227 | 9,163 | -- | 4,332 | 13,544 | -- |
| Yellow-poplar | 823,068 | 21,661 | 37,108 | 66,372 | 58,899 | 103,363 | 82,655 | 82,667 | 72,183 | 283,893 | 14,266 |
| Black walnut | 173,259 | 7,267 | 20,503 | 17,841 | 39,401 | 26,325 | 38,913 | 23,009 | -- | -- | -- |
| Other eastern soft hardwoods | 832,016 | 77,384 | 83,532 | 104,358 | 77,579 | 85,716 | 117,448 | 55,929 | 80,194 | 149,877 | -- |
| Other eastern hard hardwoods | 81,094 | 10,425 | 17,745 | 11,003 | 6,280 | 14,896 | 11,110 | 3,781 | 5,854 | -- | -- |
| Total hardwoods | 6,472,959 | 288,456 | 456,413 | 605,588 | 662,364 | 788,640 | 881,444 | 701,370 | 538,655 | 1,267,551 | 282,475 |
| **All species** | 6,707,604 | 310,325 | 494,557 | 651,819 | 713,649 | 812,952 | 916,733 | 712,714 | 544,829 | 1,267,551 | 282,475 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates that the volume rounds to less than 1 thousand cubic feet. Columns and rows may not add to their totals due to rounding.

Table 8. – Net volume of sawtimber on timberland by species group and diameter class, Indiana, 1999 - 2000

(In thousand board feet)[1]

| Species group | All classes | Diameter class (inches at breast height) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 9.0-10.9 | 11.0-12.9 | 13.0-14.9 | 15.0-16.9 | 17.0-18.9 | 19.0-20.9 | 21.0-28.9 | 29.0+ |
| **Softwoods** | | | | | | | | | |
| Loblolly and shortleaf pines | 170,218 | 19,395 | 53,842 | 37,772 | 37,530 | 21,678 | -- | -- | -- |
| Other yellow pines | 227,698 | 66,742 | 65,809 | 23,276 | 51,130 | 20,741 | -- | -- | -- |
| Eastern white and red pines | 298,568 | 43,339 | 89,304 | 28,318 | 89,961 | 16,729 | 30,917 | -- | -- |
| Jack pine | 12,851 | 7,644 | 5,207 | -- | -- | -- | -- | -- | -- |
| Other eastern softwoods | 166,567 | 96,656 | 38,370 | 31,541 | -- | -- | -- | -- | -- |
| Total softwoods | 875,902 | 233,777 | 252,532 | 120,907 | 178,622 | 59,147 | 30,917 | -- | -- |
| **Hardwoods** | | | | | | | | | |
| Select white oaks | 3,097,328 | -- | 213,591 | 391,985 | 526,578 | 372,677 | 401,376 | 878,279 | 312,842 |
| Select red oaks | 961,622 | -- | 107,488 | 124,831 | 155,279 | 134,146 | 65,884 | 288,591 | 65,403 |
| Other white oaks | 476,416 | -- | 61,563 | 97,197 | 133,454 | 58,113 | 93,685 | 32,404 | -- |
| Other red oaks | 3,094,855 | -- | 258,269 | 419,824 | 467,706 | 391,134 | 395,645 | 976,507 | 185,770 |
| Hickory | 3,265,615 | -- | 567,936 | 640,637 | 715,957 | 621,213 | 358,967 | 216,197 | 144,707 |
| Hard maple | 1,996,316 | -- | 426,321 | 333,869 | 424,408 | 374,217 | 57,771 | 315,168 | 64,561 |
| Soft maple | 435,584 | -- | 100,902 | 122,398 | 85,666 | 35,144 | 41,297 | 50,177 | -- |
| Beech | 862,156 | -- | 70,090 | 44,074 | 41,173 | 179,285 | 26,249 | 443,316 | 57,969 |
| Sweetgum | 141,323 | -- | 71,470 | 17,714 | 14,916 | 14,458 | 22,766 | -- | -- |
| Tupelo and blackgum | 214,408 | -- | 27,115 | 24,722 | 40,282 | 36,153 | 17,852 | 68,284 | -- |
| Ash | 1,633,561 | -- | 297,133 | 374,383 | 296,187 | 313,544 | 181,547 | 170,766 | -- |
| Cottonwood and aspen | 1,145,142 | -- | 72,062 | 77,792 | 112,910 | 61,619 | 115,161 | 372,149 | 333,449 |
| Basswood | 199,515 | -- | 35,606 | 31,313 | 45,735 | -- | 21,223 | 65,638 | -- |
| Yellow-poplar | 3,628,654 | -- | 292,220 | 527,414 | 429,455 | 430,198 | 381,301 | 1,496,669 | 71,397 |
| Black walnut | 617,404 | -- | 191,342 | 128,027 | 187,361 | 110,675 | -- | -- | -- |
| Other eastern soft hardwoods | 2,635,855 | -- | 360,790 | 399,007 | 548,735 | 258,255 | 368,710 | 700,358 | -- |
| Other eastern hard hardwoods | 190,768 | -- | 28,810 | 68,270 | 50,473 | 17,144 | 26,071 | -- | -- |
| Total hardwoods | 24,596,522 | -- | 3,182,709 | 3,823,459 | 4,276,274 | 3,407,975 | 2,595,506 | 6,074,502 | 1,236,098 |
| **All species** | 25,472,424 | 233,777 | 3,435,241 | 3,944,366 | 4,454,896 | 3,467,122 | 2,626,422 | 6,074,502 | 1,236,098 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates that the volume rounds to less than 1 thousand board feet. Columns and rows may not add to their totals due to rounding.

[1]International 1/4-inch rule

Table 9. – All live aboveground tree biomass on timberland by owner category, softwood/hardwood species category, and tree biomass component, Indiana, 1999 - 2000

(In dry tons)

| Owner category and softwood/hardwood category | All components | Tree biomass component | | | | | |
|---|---|---|---|---|---|---|---|
| | | All live 1-5 inch trees | Growing-stock trees | | | Non-growing-stock trees | | |
| | | | Total | Boles | Stumps, tops, and limbs | Total | Boles | Stumps, tops, and limbs |
| **Public** | | | | | | | | |
| Softwoods | 1,480,326 | 10,597 | 1,422,879 | 1,188,332 | 234,547 | 46,850 | 39,892 | 6,958 |
| Hardwoods | 31,240,361 | 2,001,922 | 27,877,961 | 20,548,257 | 7,329,704 | 1,360,478 | 963,408 | 397,069 |
| Total | 32,720,686 | 2,012,519 | 29,300,840 | 21,736,589 | 7,564,251 | 1,407,328 | 1,003,301 | 404,027 |
| **Private** | | | | | | | | |
| Softwoods | 3,582,996 | 454,508 | 2,937,396 | 2,289,484 | 647,912 | 191,093 | 132,594 | 58,498 |
| Hardwoods | 173,588,990 | 10,151,206 | 136,543,447 | 100,878,291 | 35,665,156 | 26,894,337 | 19,903,924 | 6,990,414 |
| Total | 177,171,987 | 10,605,714 | 139,480,843 | 103,167,775 | 36,313,068 | 27,085,430 | 20,036,518 | 7,048,912 |
| **All ownerships** | | | | | | | | |
| Softwoods | 5,063,322 | 465,105 | 4,360,274 | 3,477,816 | 882,459 | 237,943 | 172,487 | 65,456 |
| Hardwoods | 204,829,351 | 12,153,128 | 164,421,408 | 121,426,548 | 42,994,860 | 28,254,815 | 20,867,332 | 7,387,483 |
| Total | 209,892,673 | 12,618,232 | 168,781,683 | 124,904,364 | 43,877,319 | 28,492,758 | 21,039,819 | 7,452,939 |

All table cells without observations in the inventory sample are indicated by --. Table value of 0 indicates the aboveground tree biomass rounds to less than 1 dry ton. Columns and rows may not add to their totals due to rounding.

Schmidt, Thomas L.; Mielke, Manfred E.; Marshall, Philip T.
2002. **Indiana's forest resources in 2000.** Resour. Bull. NC-206. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 25 p.

Results of the 2000 annual inventory of Indiana show that the previous trend of increasing area of forest land and growing-stock volumes has leveled off. Deciduous species continue to dominate Indiana's forests, accounting for 96 percent of the total growing-stock volume. Known pests in Indiana's forests include the gypsy moth, eastern tent caterpillar, oak wilt, jumping oak gall, locust leaf miner, white pine weevil, oak tatters, white pine root decline, butternut canker, and pine shoot beetle.

KEY WORDS: Annual inventory, forest area, forest type, volume, biomass, Indiana

## MISSION STATEMENT

We believe the good life has its roots in clean air, sparkling water, rich soil, healthy economies and a diverse living landscape. Maintaining the good life for generations to come begins with everyday choices about natural resources. The North Central Research Station provides the knowledge and the tools to help people make informed choices. That's how the science we do enhances the quality of people's lives.

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